Automation in Sugarcane Management Plant

Dashratharaj K Shetty, Manvijay Lather, Keshav Goyal

Department of Computer Science and Engineering, Manipal Institute of Technology, Manipal University, Manipal, India

ABSTRACT

The paper proposes a Software Architecture Model for Sugarcane Life Cycle Management, thus automating agriculture Operations, such as tracking Cane Inventory, monitoring field activities, and tracking On Field Investments. The paper also has proposed various models-such as Land selection, Cane seed distribution, supply management, pre and post-harvest management, farmer payment management, contractor management and general documentations.

Keyterms: Agriculture, Automatic Generation Control, Design Automation, Sugar Industry
Area of Research: Sugarcane Life Management

INTRODUCTION

Sugarcane is a member of bamboo family of plants and is indigenous to India. It is considered one of the most promising converter of Solar Energy to Biomass and sugar. Sugar, Gur and Khandsari are the major products prepared out of sugarcane, where one third of the total sugarcane produced goes to sugar factories, the latter two entities consume two out of three fractions. It also provides raw material for manufacturing fuel and chemicals and the green top of the plant is used to feed animals. This crop is useful even after crushing, as Bagasse, the crushed cane residue is used as a fuel for electricity generator and is a very beneficial alternative for wood in paper making process. It is also used as dry fodder. Molasses, one more by-product of sugarcane is the main raw material for Alcohol based industries. Among the commercial crops of India, sugarcane has the largest value of production. It's undoubtedly one of the most versatile crop of all which makes it the obvious first choice for farmers, wherever geographical conditions favor its growth.

Objectives of this Paper

- To propose a Software Architecture model to Manage Sugarcane Life Cycle until it reaches the production stage.
- Automate the agriculture process.

LITERATURE SURVEY

1. Conditions Suitable for Growth of Sugarcane Crop

A. Temperature

Sugarcane is a long duration crop. Depending upon the variety, geographical conditions and sowing time it takes 10 to 15 and even 18 months to mature. It is planted in different times of the year in different parts of the world. In some states it is sown just once while there are states (Karnataka and Maharashtra) where its sown thrice a year, whereas in Northern states of India its sown twice a year, once around Feb to mid-May and then for Autumn plating season in October and November. Sugarcane requires an average temperature of 21°-27° for refined cultivation along with a healthy rainfall of 75cm-150cm. Hot and humid climate are favorable conditions. High humidity helps in more cane elongation. Too much rainfall or too less rainfall, both are disastrous for crop's growth. As heavy downpour could lead to low sugar content whereas inadequate rainfall results in fibrous crop. In areas receiving lesser rainfall than the prescribed limit, irrigation of the crop shows better results. For the sugarcane to be of right thickness and to be able to extract sufficient and thick juice from the cane, open skies with a temperature above 20° is preferred. Short cool dry winter season during ripening and harvesting is ideal.

High temperature and hot dry winds can cause the Red Knot disease while temperature below 0 degree Celsius can cause harm to less protected parts of the crop. Frost is detrimental to sugarcane. Therefore, if the crop is grown in northern parts of the country where winters can drop to minus degrees, it must be harvested before the onset of probable frost seasons.

B. Soil

It can grow on a large variety of soils including loams, clayey loams, black cotton soils, brown or reddish loams and even laterites. In fact, sugarcane can grow on any kind of moisture retaining soil but deep rich loamy soils are ideal for its growth. The soil should be rich in nitrogen, calcium and phosphorus but at the same time, it should have pH ranging from 5.0 to 8.0, in other words, it should not be either too acidic or too alkaline. As this is a long duration crop and remains in the field for 12 to 18 months, it requires very fertile soil and due to this its cultivation requires heavy dose of manures and fertilizers. To facilitate easy irrigation and transportation of cane to the sugar mills, a plain and levelled plateau is advantageous. Since sugarcane cultivation is highly labor intensive, cheap abundant labor is a prerequisite for its successful cultivation. Hence, ample human hands at every stage i.e. from sowing, hoeing, weeding, irrigating, and cutting to carrying sugarcane to the factories are necessary.

PRODUCTION

Known to have the largest area under sugarcane cultivation in the world, India is also the world's second largest producer of sugarcane next after Brazil, while China and USA hold the third and tenth spot respectively. As per records there was a drastic increase of 93 per cent of cane production during 1951-61 as a result of diversification of agriculture but this spurt plummeted to 14.9 per cent growth in the decade 1961-71 owing to internal market fluctuations which made farmers lose credence and confidence in the profitability of the crop. From this decade onwards, sugarcane cultivation saw upwards trend for three upcoming decades and mostly in the decade 1971-81 where it saw a growth rate of 22% as the market was expanding with the introduction of more sugar mills. However, the production of this versatile crop reached an all-time high of 299.3 million tons at the turn of the millennium after which varying trends have been observed. Four years later, in 2003-04, production of sugarcane in India was recorded at 236.4 million tons, over 60 million tons lesser than what was produced in 1999-00. Area under cultivation of sugarcane followed the same trend as the production of the crop as it registered a swift raise during the latter half of 20th century and then saw a fall right after the onset of the millennium. From a sprawling 1.7 million hectares of land under sugarcane cultivation in 1950-51 to a magnetics 4.1 million hectares in 1998-99, the numbers saw some saturation soon after. In fact, active cultivation area dropped from 4.4 million hectares in 2002-03 to 4.0 million hectares in 2003-04.

Now the third quantity, which is integral in analyzing the growth of a crop over the years, is, the yield of that crop. Yield is calculated by dividing the amount of crop produced by the area of cultivation of the crop. Yield of sugarcane also followed the same trend as its atomic quantities. It significantly increased twofold from 1951 to 1998 soaring escalating from just 33 tons/hectare in the season 1950-51 to 65 tons/hectare in 1990-91. This upward trend continued until 1997-98 when it reached 71 tons/hectare. The yield remained at this level for three consecutive years from 1997-98 to 1999- 2000. However, soon after the yield rapidly tapered off to 59 tons/hectare only in 2003-04. The probable cause of this rapid decline could be either exhaustion of soils or lack of modem agricultural inputs. In comparison to a healthy sugarcane yield from countries such as Indonesia, Egypt and Mexico, India's produce does not stand in strong numbers with the respective countries mentioned above who produce at least 50 per cent more sugarcane/hectare as compared to us. Multiple reasons have been cited and many conclusions been drawn in view of the major causes of low yield in India. Most of them being the lack of fertilizers, uncertain weather conditions, inadequate irrigation, poor varieties of cane, small and fragmented holdings and backward methods of cultivation.

DISTRIBUTION

Based on study of aforementioned conditions of growth for sugarcane we can identify three different belts of cultivation of this crop in India as following:

First, The Satluj-Ganga plain, expanding from Punjab (in the West) to Bihar (towards the East). It contains 51 per cent of the total area under sugarcane cultivation. In addition, this belt produces 60 per cent of the country's total sugarcane.

Table 1

Year	Production (million tons)	Area (million hectares)	Yield (tons/hectares)
1950-51	57.0	1.7	33
1960-61	110.0	2.4	46
1970-71	126.4	2.6	48
1980-81	154.2	2.7	58
1990-91	241.0	3.7	65
1997-98	279.5	3.9	71
1998-99	288.7	4.1	71
1999-00	299.3	4.2	71
2000-01	296.0	4.3	69
2001-02	298.0	4.4	67
2002-03	281.6	4.4	65
2003-04	236.4	4.0	59

Second, The Black Soil Belt that runs along the eastern slopes of the Western Ghats, and located in the southern part of this South-East Asian country containing the area in between Maharashtra and Tamil Nadu.

Third and final being, the Coastal Andhra and the Krishna Valley region, which is situated towards the Bay of Bengal.

METHODOLOGY

The main approach to achieve the objective is using use case diagrams and activity diagrams to automate the various operations involved in the sugarcane management plant. The diagrams are useful in explaining the automated operation and the purpose involved.

FINDINGS/DISCUSSION

1. Use Case Diagram

Figure 1 and Table 2 give the details about the functionality expected from the system.

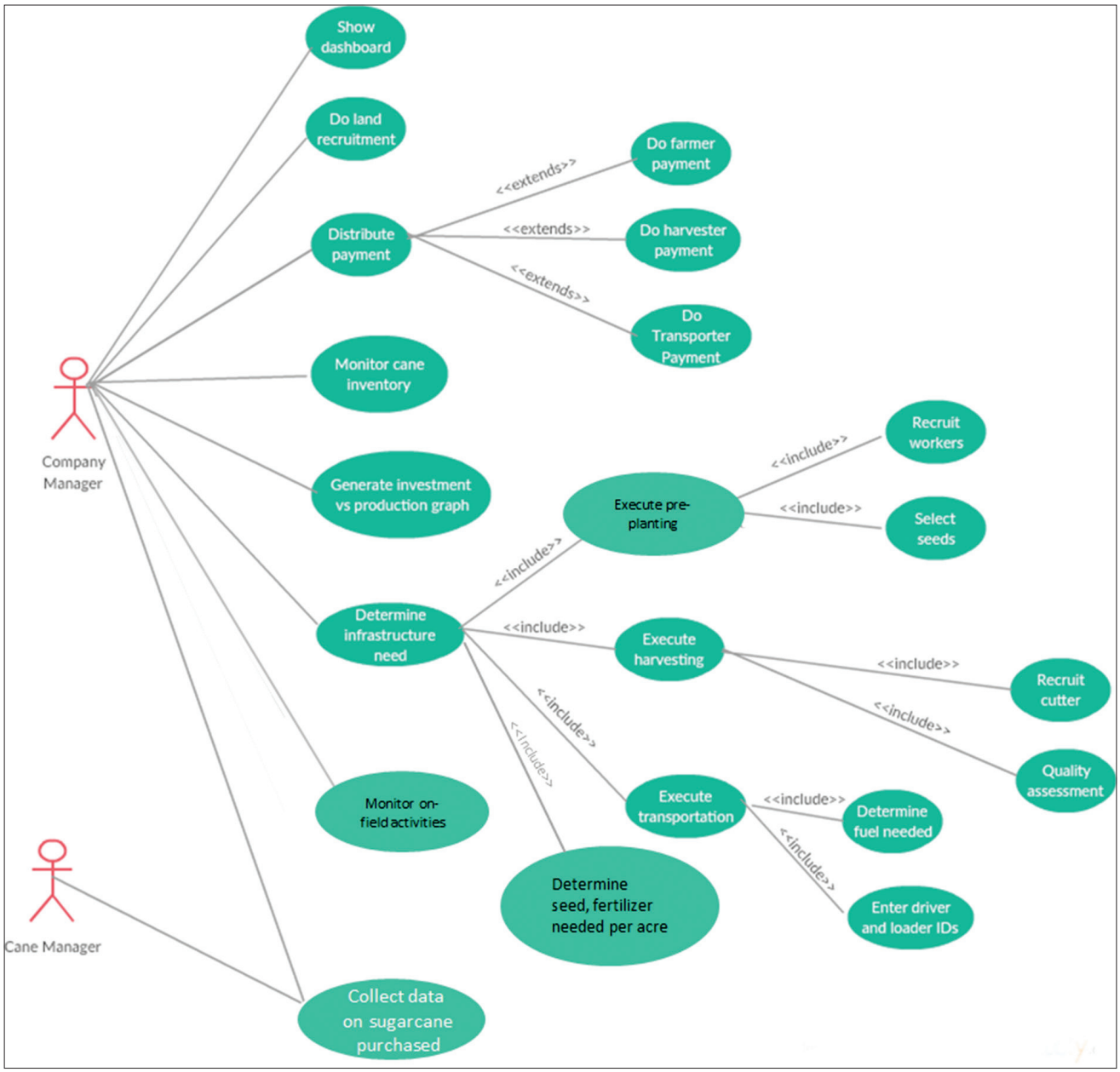


Figure 1: Use case diagram showing system functionality

Table 2: Use case description of system functionality

Use case	Description	Actors
Show dashboard	Show the dashboard containing the various cane activities to user	 Company Manager
Do land recruitment	Capture the land recruitment application Approval/rejection of land Farmer contract signing confirmation	 Company Manager
Distribute payment	Pay all the middle users – the farmers, harvesters, and transporters on time	 Company Manager
Monitor cane inventory	Keep track of amount of sugarcane at the factory at any given time	 Company Manager
Generate investment versus production graph	Generate reports of specified format with the correct data in accordance to the need of top management	 Company Manager
Determine infrastructure need	Recruitment of workers and cutters Machinery allocation for pending land area	 Company Manager
Monitor on-field activities	Soil analysis Sugarcane juice analysis Seed cane inspection	 Company Manager
Collect data on sugarcane purchased	Cane manager will manage the data of sales and purchase which helps in producing investment versus production graph	 Company manager  Cane Manager
Do farmer payment	Pay the farmers for the sugarcane crop post-delivery	 Company Manager
Do harvester payment	Pay the harvester post harvesting of crop	 Company Manager

(Contd...)

Table 2: (*Continued*)

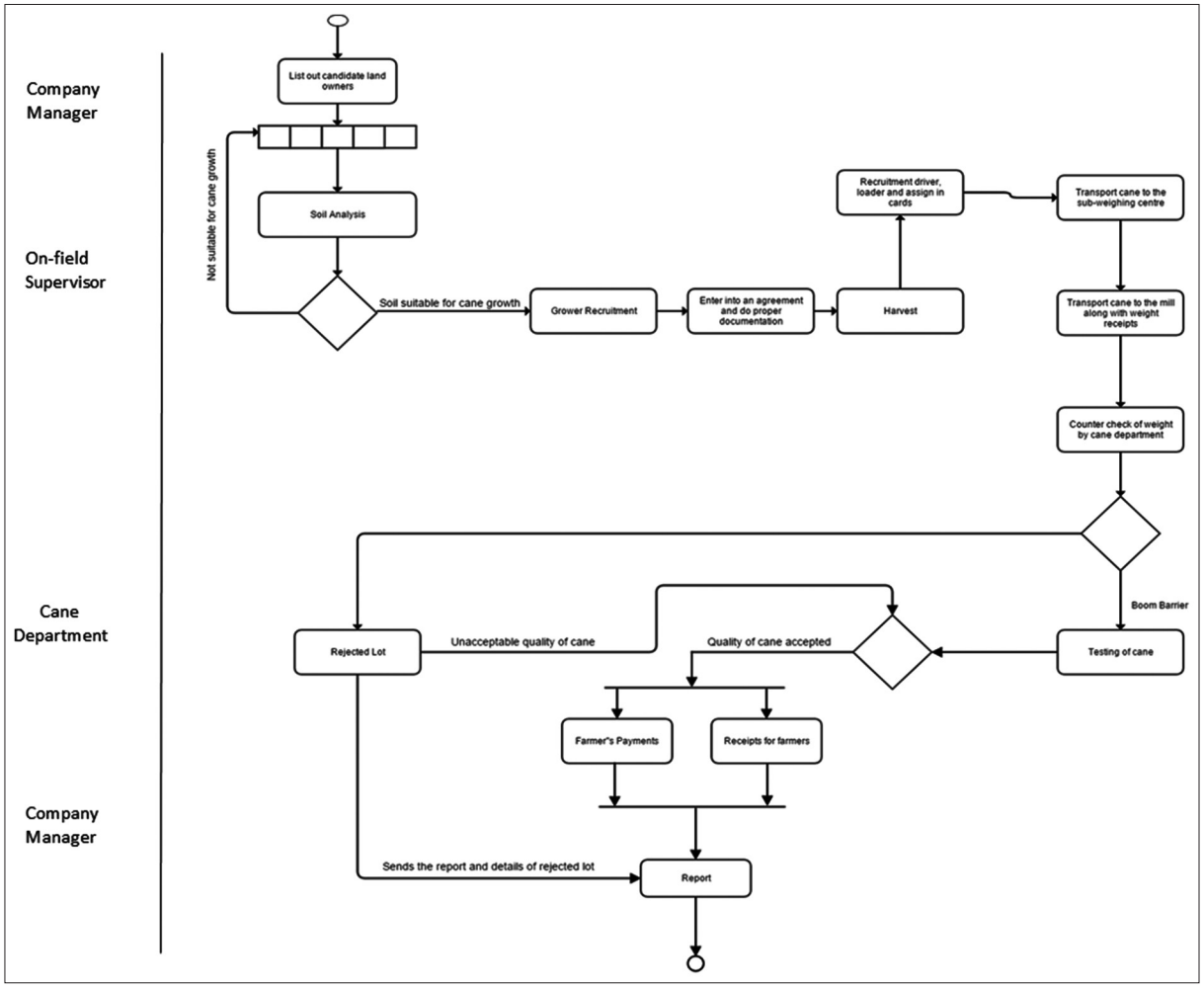
Use case	Description	Actors
Do transporter payment	Pay the driver and loader	 Company Manager
Execute pre-planting	Recruit workers Select seeds for the crop	 Company Manager
Execute harvesting	Recruit the cutter. Check how updated is the technology the harvester is using by feeding in the system the model number of machines	 Company Manager
Execute transportation	Determine fuel needed per round Assign ids to loader and driver of truck/tractor	 Company Manager
Determine seed, fertilizer needed per acre	Formulize the amount of seed and fertilizer needed per acre of land	 Company Manager
Recruit workers	Create the database of workers on the sugarcane field	 Company Manager
Select seeds	Brand/quality of the seeds to be sown needs to be updated every season	 Company Manager
Recruit cutter	Recruit the harvesting contractor for the job	 Company Manager
Quality assessment	Machines used in the harvesting process have to be at or above the standard described by the company	 Company Manager
Determine fuel needed	Fuel needed per round of truck/tractor while delivering the crop	 Company Manager

(Contd...)

Table 2: (*Continued*)

Use case	Description	Actors
Enter driver and loader ids	Assign ids to driver and loader and save them in the database	Company Manager

2. Activity Diagram and Description



3. Software Architecture

The proposed system has five layers:

Presentation layer: This layer acts as the user interface for system, in which all the data and content are displayed based on the end user generated events. The system will be made accessible through a variety of platforms like android, web browser, mobile browser. Based on the demands of the user, appropriate requests will be sent to the server and results generated in the business layer will be displayed to the client.

Infrastructure Service layer: This layer will mainly consist of services like authentication, authorization, caching, validation, logging, exception handling and session management. Logging of trace information generated during business processes helps in exception handling, it also facilitates authentication and validation of the user inputs and the resources shared in the system. Caching helps in improving performance by moving frequently accessed data from the slow secondary store to the primary memory. Authorization prevents unnecessary tampering of data resources.

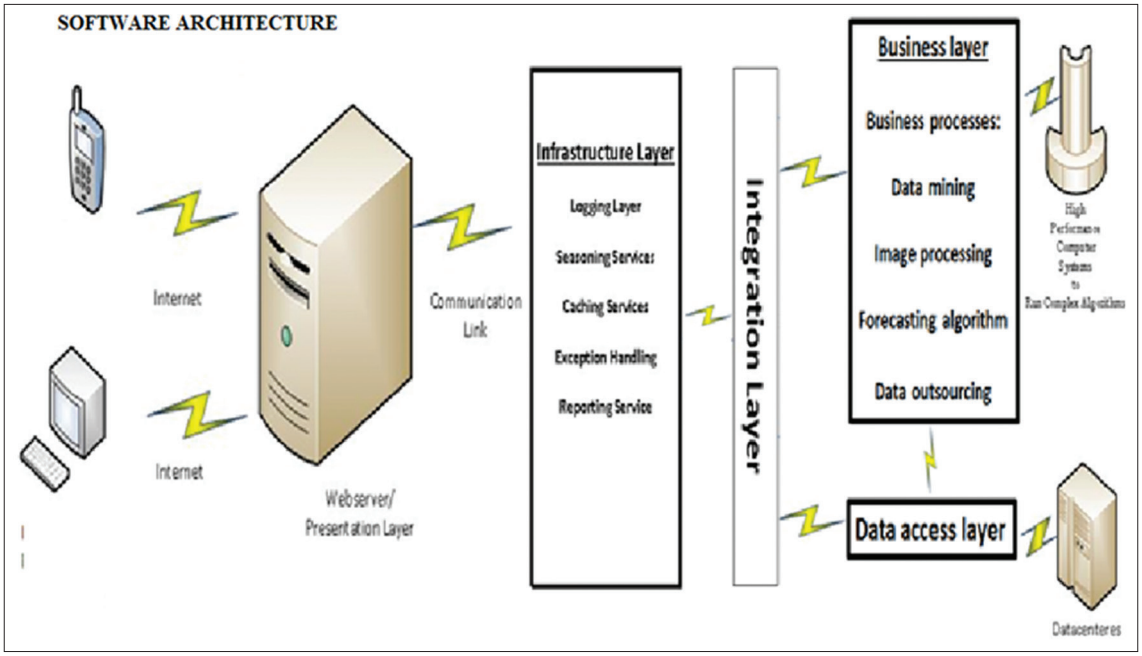


Figure 2: Software architecture model of the proposed model

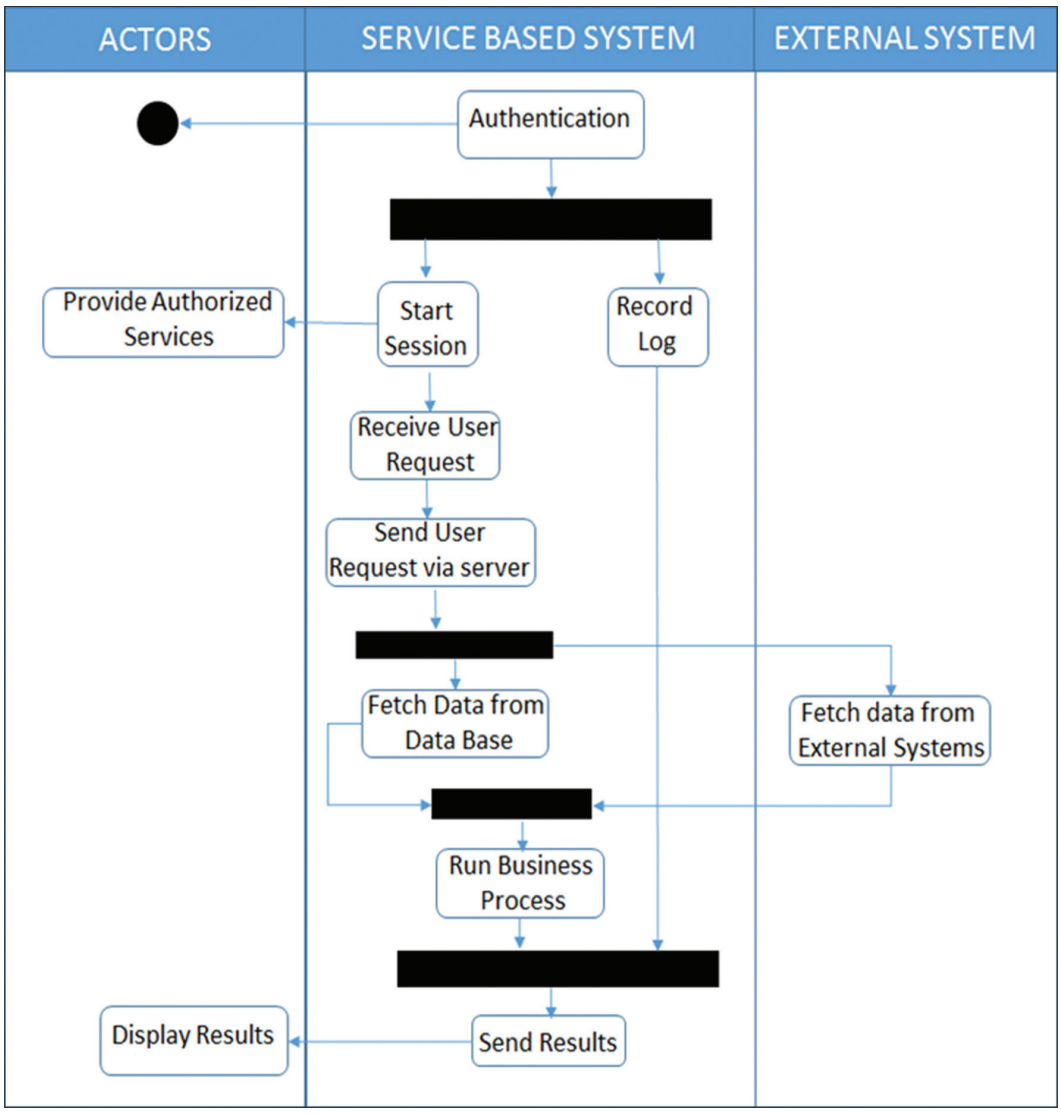


Figure 3: Service Oriented Software Architecture

Business layer: This layer will mainly consist of the business processes like data mining, image processing, data (example: orders for transportation) outsourcing, forecasting algorithms etc.

Data access layer: The business layer through the data access layer fetches data, required for various business purposes.

Integration layer: Integration layer helps the layers communicate with each other.

The client has to register himself only once. The users will have to authenticate themselves every time they access the system. During every session, trace information of all user actions is logged into the system. Based on the authorization of the user, various options are displayed. Every time a request is made, the business layer fetches appropriate data from the databases and external sources for application of the business logic and the appropriate results are displayed on the presentation layer. The business logic mainly consists of processes like data mining, image processing, data outsourcing, forecasting. The data outsourcing refers to outsourcing the order placed by the clients to transportation companies and based on the response, the client can choose either to which company the contract must be given or the winner can be chosen by using a biding model where the lowest bidder is given the contract hence ensuring quality services at reasonable rates.

CONCLUSION

The software architecture model for the sugarcane management plant has been designed to tackle the challenges posed by existing solution of pre planting, harvesting and transportation. By fully automating the system, it is possible to easily keep track of the cane inventory, all the on-field activities and all the investment done on the field along with the productivity generated from the field.

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